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10/649,310	08/27/2003	Cheng-Ming Lin	TSM02-0936	5405
43859	7590	12/12/2005	EXAMINER	
SLATER & MATSIL, L.L.P. 17950 PRESTON ROAD, SUITE 1000 DALLAS, TX 75252			RUGGLES, JOHN S	
			ART UNIT	PAPER NUMBER
			1756	

DATE MAILED: 12/12/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

10/649,310

Applicant(s)

LIN, CHENG-MING

Examiner

John Ruggles

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 11/25/03 & 8/27/03.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-39 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-39 is/are rejected.
- 7) ☒ Claim(s) 1-39 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 27 August 2003 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

## Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

## Attachment(s)

- ☒ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date 11/25/03.
- ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_.
- ☐ Notice of Informal Patent Application (PTO-152)
- ☐ Other: \_\_\_\_\_.

**DETAILED ACTION*****Drawings***

The drawings are objected to as failing to comply with 37 CFR 1.84(p)(4) because reference character "D<sub>2</sub>" has been used to designate both (i) the depth of the recess etched in the transparent substrate 22 in clear area 26 (as shown by Figure 4) and (ii) the remaining thickness of attenuated phase shifting material 24 in clear area 26 after etching (as shown by Figure 6).

The first meaning (i) of "D<sub>2</sub>" as the depth of the recess in the transparent substrate 22 is stated, for example, at paragraph [0024] lines 15 and 22, while the second meaning (ii) of "D<sub>2</sub>" as the remaining thickness of attenuated phase shifting material is given, for example, at [0028] line 20.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

***Specification***

The title of the invention is not fully descriptive. A new title is required that is clearly indicative of the invention to which all of the claims are directed.

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The following title is suggested: --ATTENUATED PHASE-SHIFTING MASKS AND METHODS OF MAKING [[AN]] ATTENUATED PHASE-SHIFTING MASKS FROM [[A]] MASK BLANKS--.

The disclosure is objected to because of the following informalities: (1) in paragraph [0010] line 5, “first thickness also, or in alternative, may be designed” should be changed (e.g., to --first thickness ~~also, or in alternative~~[[,]] may alternatively be designed--, etc.); (2) in [0013] line 1, “attenuate” should be corrected to --attenuated--; (3) in [0016] line 2, “views, illustrative embodiments” should be changed (e.g., to --views, and illustrative embodiments--, etc.); and (4) in [0032] line 2, “embodiments the present invention” should be corrected to --embodiments of the present invention--. In order to further improve readability, it is also suggested that (5) in [0009] line 1, “present invention, method of making” be changed to --present invention, a method of making-- and (6) in [0006] lines 6-7, “such case” be changed to --such a case--.

Appropriate correction is required.

### ***Claim Objections***

Claims 1-39 are objected to because of the following informalities: (1) in claim 1 lines 3-4 and 6-8 (and throughout the claims depending on claim 1 as needed at all occurrences, at least in claim 4 line 1 and claim 9 lines 1 and 3), in claim 29 lines 4-5, and also in claim 35 lines 4-5, “the phase-shifting layer” should be changed to --the attenuating and phase-shifting layer-- at all applicable occurrences, in order to be consistent with the latter phrase recited earlier in claim 1 line 2, in claim 29 line 3, and also in claim 35 line 3, respectively; (2) in claim 12 line 1 and also

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in claim 31 line 2, "attenuation" should be changed to ~~--attenuation~~ attenuating-- (at both occurrences), in order to be consistent with the latter term in claim 1 line 2 (on which claim 12 depends) and also in claim 29 line 3 (on which claim 31 depends), respectively; and (3) (a) in claim 13 line 7, "the forming dark areas" should be changed to ~~--forming the forming plurality of~~ the plurality of dark areas-- and (b) also in claim 13 line 9, "forming clear areas" should be changed to ~~--forming~~ the plurality of clear areas--, both in order to better correspond with these phrases in claim 13 lines 6 and 5, respectively. Claims 2-12 depend on claim 1, claims 14-28 depend on claim 13, claims 30-34 depend on claim 29, claims 32-33 depend on claim 31, and claims 36-39 depend on claim 35. Appropriate correction is required.

***Claim Rejections - 35 USC § 112***

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claim 6 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim contains subject matter, which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. While paragraph [0008] on page 4 of the specification supports the actual language of claim 6 requiring the second (target) wavelength ( $\lambda_t$ , for which the attenuated PSM is be used) to be greater than the first wavelength ( $\lambda_0$ , for which the attenuated PSM blank was designed), this language is not sufficiently described to enable one of ordinary skill in the art to clearly understand the purpose for reducing

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the thickness of the attenuated PS material to accommodate a target wavelength that is larger than the exposure wavelength for which the attenuated PSM blank was designed ( $\lambda_t > \lambda_0$ ). In fact, the expressions for the target relative PS ( $\Phi_t$ ) disclosed in connection with instant Figures 4 and 6 in paragraphs [0024] and [0028], respectively, only support reducing the thickness of the attenuated PS material to accommodate a target wavelength that is *smaller* than the exposure wavelength for which the attenuated PSM blank was designed ( $\lambda_t < \lambda_0$ ). Accordingly, for the purpose of this Office action and in order to advance the prosecution of this application, the language of claim 6 has been interpreted to mean that the second (target) wavelength is *smaller* than the first wavelength ( $\lambda_t < \lambda_0$ ).

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 13-28 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 13 lines 10-11, it is unclear whether the phrases “clear areas” in line 10 and “the clear areas” in line 11 are meant to refer to (1) the “plurality of clear areas” recited earlier in claim 13 line 5 or (2) a different set of clear areas. For the purpose of this Office action and in order to advance the prosecution of this application, the “clear areas” in claim 13 line 10 is interpreted to mean --the plurality of clear areas-- and “the clear areas” in claim 13 line 11 is interpreted to mean --the plurality of clear areas--, both in accordance with (1) above. Claims 14-28 depend on claim 13.

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In claim 17 line 2, it is unclear whether “the first thickness” is intended to mean (3) the “first default thickness” (as recited in claim 13 line 2, on which claim 17 depends, emphasis added) or (4) the “first adjusted thickness” (as recited in claim 13 line 8, on which claim 17 depends, emphasis added). For the purpose of this Office action and in order to advance the prosecution of this application, “the first thickness” in claim 17 line 2 is interpreted to mean --the first adjusted thickness--, in accordance with (4) above. Claims 18-19 depend on claim 17.

In claim 26 line 2, it is unclear whether “the clear areas” is meant to refer to (5) the -- plurality of clear areas-- recited in claim 13 line 5 (on which claim 26 depends) or (6) a different set of clear areas in claim 13 (e.g., in claim 13 lines 9, 10, 11, etc.). For the purpose of this Office action and in order to advance the prosecution of this application, “the clear areas” in claim 26 line 2 is interpreted to mean --the plurality of clear areas-- (as recited in claim 13 line 5), in accordance with (5) above. Claims 27-28 depend on claim 26.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1, 5-11, and 35-39 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mitsui et al. (US Patent 6,242,138).

Mitsui et al. teach a halftone (attenuated) phase shift mask (PSM), a method of manufacturing an attenuated PSM, and an attenuated PSM blank therefore (title, abstract, col. 1 lines 11-19). This attenuated PSM satisfies various optical characteristics (e.g., light (optical) transmission, amount of phase shift (PS), etc.) with high precision, as well as reducing defects in the thin film of a light translucent or semi-transparent portion (abstract, col. 1 lines 45-56), which is understood to mean an attenuating and PS layer 3a formed over a transparent substrate layer 1 (as shown in Figure 2, col. 7 lines 8-10). A typical conventional halftone (attenuated) PSM has a transparent substrate 1, a clear light transmitting portion 2, and attenuating PS portion 3, which is shown by Figure 1(a) and described at col. 1 lines 57-66. The transparent substrate is made of clear material (e.g., quartz, etc., col. 5 line 65) and the light (optical) transmission T of the attenuating PS layer to the exposure light is preferably about 2-20% (col. 5 lines 15-17). A lower optical transmission T is preferable for line and space patterns, while a higher optical transmission T is preferable for hole system patterns (col. 5 lines 21-24). Figure 6 shows a graph for the dependency of light (optical) transmission (T, %) as a function of the wavelength ( $\lambda$ ) of exposure light (e.g., T = 5% at  $\lambda = 248\text{nm}$ , T = 19% at  $\lambda = 365\text{nm}$ , T = 40% at  $\lambda = 488\text{nm}$ , etc., col. 8 lines 13-25) through an attenuated PSM blank having a constant thickness (e.g., 931 Angstroms ( $\text{\AA}$ ), etc.) of an attenuated MoSiON PS layer for a PS =  $181^\circ$  (Figure 5, col. 8 lines 10-13). Figure 5 also shows that for the same exposure wavelength ( $\lambda = 248\text{nm}$ ) and nearly the same or slightly smaller PS ( $180^\circ$ ), increasing the thickness of the attenuated MoSiON PS layer from 931  $\text{\AA}$  to 1378  $\text{\AA}$  (Comparative Example No. 1) decreases the transmission (T) of exposure light from 5% to 2%, respectively (col. 8 lines 26-44). Thus, (optical) transmission T decreases with decreasing wavelength  $\lambda$ , but T increases with decreasing thickness of the attenuated PS



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layer, and the amount of PS is nearly the same (approximately equal) or increases with decreasing thickness of the attenuated PS layer. The method of manufacturing or fabricating the attenuated PSM from an attenuated PSM blank (e.g., having a MoSiON attenuating PS layer, etc.) involves patterning a resist on the attenuating PS layer of the PSM blank, then removing portions of the attenuating PS layer through the resist pattern by etching (e.g., using dry etching with a gas including  $\text{CF}_4$ , etc., col. 9 lines 18-25 and col. 10 lines 3-8 and 22-28).

Mitsui et al. do not specifically teach thinning of the attenuated PS layer on the attenuated PSM blank for a first wavelength of exposure light to adapt the blank for making an attenuated PSM usable at a second wavelength of exposure light that is different from the first wavelength.

However, it would still have been obvious to one of ordinary skill in the art at the time of the invention that the attenuated PSM blank having an attenuated PS layer (e.g., of MoSiON, etc.) with an initial or default thickness ( $D_0$ ) adapted for a first predetermined PS and (optical) transmission ( $T_0$ ) at a first wavelength ( $\lambda_0$ ) of exposure light (as taught by Mitsui et al.) would be suitable for making an attenuated PSM usable at a second (e.g., shorter, etc.) target wavelength ( $\lambda_t$ ) of exposure light by sufficiently reducing the entire attenuated PS layer initial (default) thickness  $D_0$  to a first (adjusted) thickness ( $D_1$ ) and removing an additional portion of the remaining attenuated PS layer to form a clear area having a second thickness ( $D_2$ ). This is because Mitsui et al. teach that (optical) transmission  $T$  of the attenuated PS layer decreases with decreasing wavelength  $\lambda$ , but that  $T$  increases with decreasing thickness of the attenuated PS layer, and that the amount of PS is nearly the same (approximately equal) or increases with decreasing thickness of the attenuated PS layer. This attenuated PSM and method of manufacturing this attenuated PSM would be expected to satisfy various desired optical

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characteristics (e.g., optical transmission, amount of PS, etc.) with high precision, as suggested by Mitsui et al. (instant claims 1, 5-11, and 35-39).

Claims 2, 13-20, 23, 26, and 29-34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mitsui et al. (US Patent 6,242,138) in view of Takushima (US Patent 6,508,949).

Mitsui et al. do not specifically teach removing portions of the transparent substrate to form a recess at the clear area or portion having a first recess depth.

Takushima teaches a method for correcting characteristics of an attenuated phase shift mask (PSM, which is widely used for forming a minimized circuit (design) micropattern due to simple construction, col. 1 lines 22-38). Such characteristics to be corrected include (optical) transmittance and/or phase difference (phase shift, PS) (title, abstract, col. 2 lines 1-2). The correction method includes removing portions of the transparent substrate to form a recess having a recess depth at the clear areas by controlled etching (e.g., dry etching, etc.) of the transparent substrate 412 between adjacent regions having attenuated PS layer 414, as shown in Figures 12D and 12E (col. 8 line 50 to col. 10 line 60).

It would have been obvious to one of ordinary skill in the art at the time of the invention in the attenuated PSM and method of manufacturing thereof (as taught or suggested by Mitsui et al.) that further includes removing portions of the transparent substrate (e.g., having a second default thickness, etc.) to form a recess having a first recess depth ( $D_2$ , e.g., by reducing the second default thickness to a second adjusted thickness, etc.) at the clear areas by controlled etching (e.g., dry etching, etc.), in order to correct optical characteristics of the attenuated PSM

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(e.g., optical transmittance, amount of PS, etc.), as taught by Takushima (instant claims 2, 13-20, 23, 26, and 29-34).

Claims 3, 21-22, 24-25, and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mitsui et al. (US Patent 6,242,138) in view of Takushima (US Patent 6,508,949) and further in view of Shiota et al. (US Patent Application Publication 2002/0122991).

Mitsui et al. and Takushima do not specifically teach reactive ion etching (RIE) using an etching chemistry that includes at least one of  $\text{CF}_4$  or  $\text{SF}_6$  (instant claims 3, 21-22, 24-25, and 27).

Shiota et al. teach a halftone (attenuated) phase shift mask (PSM), a method of manufacturing an attenuated PSM, and an attenuated PSM blank therefore (title, abstract, paragraph [0002]). In order to obtain a sufficient processing precision in etching the PSM blank, anisotropic etching should be carried out at least in the depth direction. For this anisotropic etching, dry reactive ion etching (RIE) by a fluoride gas (e.g.,  $\text{CF}_4$ ,  $\text{SF}_6$ , mixture of gases, etc.) is widely used in the art [0071]. Such etching of an attenuating PS layer and an underlying transparent substrate (e.g., usually quartz, etc.) is fairly rapid and requires careful control to prevent over-etching of substrate [0072-0073].

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention in the attenuated PSM and method of manufacturing thereof (as taught or suggested by Mitsui et al. and Takushima) to remove the attenuating PS material and optionally also a portion of the underlying transparent substrate at clear areas of the attenuated PSM by carefully controlled anisotropic RIE using a fluoride gas (e.g.,  $\text{CF}_4$ ,  $\text{SF}_6$ , mixture of gases, etc.) to prevent

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over-etching (e.g., of the underlying transparent substrate, etc.), because this type of etching is widely used in the art (as taught by Shiota et al., instant claims 3, 21-22, 24-25, and 27).

Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Mitsui et al. (US Patent 6,242,138) in view of Chen (US Patent 6,274,281).

Mitsui et al. do not specifically teach that a part of the attenuating PS layer with a second thickness remains at the clear areas of the attenuated PSM, wherein the second thickness is less than the previous first thickness of this layer (instant claim 4).

However, it is known to make an attenuated phase shift mask (PSM) having a part of the attenuating (PS) layer with a second thickness remaining at the 0° (clear) areas between densely spaced lines or features of the attenuated PSM, in which the second thickness is less than the previous first thickness of this layer (as taught by Chen, abstract). Chen describes an attenuating PSM made by coating a resist 60 on a mask blank having a PS material 45 on light absorbing semi-transparent (attenuating) layer 43 (with a first thickness 49 for a first transmittance of about 4% to 20%) on a transparent substrate 40 (as shown by Figure 4), patterning the resist 60 (e.g., by electron beam, etc., as shown in Figure 5), then etching through the resist to only partially etch through and reduce the thickness of the attenuating layer 43 (at positions 46, down to a second thickness for a second transmittance of about 90% to 99%, which are relatively clear areas) between densely spaced features 44 (Figure 6, col. 4 line 28 to col. 5 line 14). The reduced thickness of attenuating material 43 at positions 46 between densely spaced features 44 provides improved image quality, while avoiding the necessity of an optical proximity correction (OPC) method (col. 5 lines 14-19).

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Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention in the attenuated PSM and method of manufacturing thereof (as taught or suggested by Mitsui et al.) to remove only a portion of the attenuating PS material at clear areas of the attenuated PSM so that a part of the attenuating PS layer with a second thickness remains at the clear areas of the attenuated PSM, wherein the second thickness is less than the previous first thickness of this layer. This is at least because the remaining reduced thickness of the attenuating PS layer at the clear areas between closely spaced features provides improved image quality, while avoiding the necessity of an optical proximity correction (OPC) method (as described by Chen, instant claim 4).

Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Mitsui et al. (US Patent 6,242,138) in view of Shiota et al. (US Patent Application Publication 2002/0122991).

Mitsui et al. do not specifically teach reactive ion etching (RIE) using an etching chemistry that includes at least one of  $\text{CF}_4$  or  $\text{SF}_6$  (instant claim 12).

The teachings of Shiota et al. are discussed above.

It would have been obvious to one of ordinary skill in the art at the time of the invention in the attenuated PSM and method of manufacturing thereof (as taught or suggested by Mitsui et al.) to remove the attenuating PS material at clear areas of the attenuated PSM by carefully controlled anisotropic RIE using a fluoride gas (e.g.,  $\text{CF}_4$ ,  $\text{SF}_6$ , mixture of gases, etc.) to prevent over-etching (e.g., of the attenuating PS material, etc.), because this type of etching is widely used in the art (as taught by Shiota et al., instant claim 12).

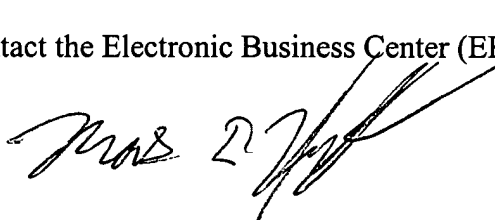
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***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Ruggles whose telephone number is 571-272-1390. The examiner can normally be reached on Monday-Thursday and alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 571-272-1385. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

  
**MARK F. HUFF**  
**SUPERVISORY PATENT EXAMINER**  
**TECHNOLOGY CENTER 1700**

  
**John Ruggles**  
**Examiner**  
**Art Unit 1756**